Guidelines for Management of Electrical Hazards in Pipeline Constructing

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Electricity and electrically powered tools are an essential element of steel pipeline construction. However, there are hazards which have the potential for injury and death by contact with electrical energy, the risk may be high and will need to be managed effectively during pipeline construction activities.

Furthermore, the hazards and potential risk increases year by year as more easements are approved along overhead power line corridors and through areas that have buried power services.

ELECTRICAL HAZARDS

The following list identifies electrical hazards to which pipeline construction workers may be exposed:

- Overhead Power Transmission Lines
- Underground Power Services
- Static Electrical Energy Generation
- Portable Power Generation Equipment and Electrical Powered Tools

Each of these sources of electrical energy have the potential to cause severe injuries and fatalities.

THE HAZARDS AND MANAGEMENT TO REDUCE RISK

OVERHEAD POWER TRANSMISSION LINES

1. Direct Contact

Usually facilitated by misuse of plant and equipment such as sidebooms, other cranes, excavators and in fact, any mobile plant that could come into contact with, or close proximity to overhead power lines.

In such cases, electrical energy is conducted through the equipment and the person operating it. Very often, if the mobile plant is metal tracked, the operator will survive this contact so long as he stays on the machine.

Depending on the voltage being carried by the system, tyres of wheeled equipment coming into contact can be blown out and persons some distance away from the incident can be injured by the light and heat energy released by the electrical discharge.

The power transmission system will register the contact as a line fault and trip the supply. Normally, the system will try and reset the trip, all with in seconds. A second trip will normally occur and the system at fault will then remain isolated.

Management

IDENTIFY the location and voltage of overhead power lines that run across or adjacent to the pipeline easement.
PRE-PLAN work activities adjacent to or underneath power lines, including placement of appropriate signage and safe clearance catenary wires.
LIAISE with the power authority and where practicable have the power lines isolated during operations with high plant/equipment. But STILL TREAT ALL POWER LINES AS LIVE and work accordingly.
INFORM the work crews on a daily basis of the location, height and voltage of power lines they will be working adjacent to or under.
REVIEW the Crew's JSAs with them and ensure that risk reduction methods are identified and understood by all crew members.
CONFIRM the emergency procedure in case of power line contact with the Power Authority and all crew members on a regular basis.

2. Induced Voltage

This is the effect of proximity to overhead power lines. The power line fluctuating electric and magnetic fields can induce a potential in the pipeline, that can rise to a level of many thousand volts in normal operation. This is known as the *Capacitor and transformer effect.*

This effect relies on three criteria

- System voltage
- Distance from the power line
- Number of 'bays' (gap between two power poles) the pipe string is welded over

Management

Earthing of pipe strings must be efficient to ensure electrical potential in the sting is rapidly discharged.

- Ensure a good connection of earth cable to the pipe string (a bolted clamp is preferable to a crocodile clip)
- Ensure the earth stake is driven well into the ground where practicable and in extremely dry conditions, keep the ground around the stake damp to improve its conductivity and lessen resistance
- Maintain the earthing whilst moving pipe strings eg. when lowering in

REMEMBER HUMAN BODIES ARE VERY GOOD CONDUCTORS OF ELECTRICITY, earthing systems need to be more efficient than the human body or they will be a waste of time.

The tables in this guideline are taken from AS 3000 and AS 3007 and give the distances from power lines that welded pipe stings can be located, to ensure that the maximum allowable potential rise in the pipe string is not exceeded. These Standards also give tables containing the earth stake or bed resistance and the distance between installations that is required to reduce the resistance and give more effective earthing.

3. Power Line Transmission Fault

Remote or local faults on electric power transmission lines can cause large unbalanced currents in the overhead conductors, which can induce high voltages in adjacent pipelines by the transformer effect.

Additionally, an insulator breakdown at a pylon/tower can cause the high power line fault current to flow to earth, raising the surrounding soil potential to very high voltages. In both cases the resulting current will take the line of least resistance. Generally, a string of welded pipeline will tend to have less resistance than the ground and of course a good connection by way of the earthing systems.

In Australia, power transmission systems are well maintained and the probability of this occurrence is extremely low. However, the outcome should it occur in the vicinity of pipeline construction could be catastrophic due to the number of persons who may be in contact with the pipe at the time.

Unfortunately, Power Line Authorities cannot predict such events and would not be aware of a fault until it actually occurred.

Management

Whenever this hazard is present, the risk will be high and minimisation strategies must be implemented and maintained. In this case, it is essential that ALL persons liable to come into contact with earth steel pipe strings, are at the same potential as the pipe. This can be achieved by the use of equipotential screen mats, importing low resistance oil or applying a low conductivity fluid to the ground adjacent pipe strings.

In all these cases, there must be connection to a running earth.

When considering the strategies outline above, thought must be given to environmental management. Importation of soils, especially if they contain seeds of non indigenous plants an pollute the local environment, as can fluids containing chemicals that lower resistivity.

Other strategies:

- Information on the hazard for workforce, to ensure compliance with the requirement of equipotential systems
- Maintenance of the systems, preferably by a dedication crew that should include a licensed electrician familiar with the hazards
- Signage at the approaches to pipe strings, warnings or hazards

UNDERGROUND POWER SERVICES

Digging up a live underground power cable during pipeline construction is a rare event. However, should it occur, it may be accompanied by damage to the insulation, which results in electrical energy to be conducted through equipment that comes into contact with the live power source. Implications are that the equipment will transfer the energy on to the persons operating the equipment, which often have the same outcome as contact with overhead power lines.

Management

IDENTIFY the location and voltage of underground power cables that run across or adjacent to the pipeline easement.
PRE-PLAN work activities, including hand digging to expose cables and added protection for exposed cable during lowering of pipe strings.
LIAISE with the Power Authority and where practicable have the power cables isolated during exposure activities. STILL TREAT ALL POWER CABLES AS LIVE and work accordingly.
INFORM the work crews as required of the location, depth and voltage of power cables they will be working adjacent to or under.
REVIEW the Crew's JSAs with them and ensure that risk reduction methods are identified and understood by all crew members.
CONFIRM the emergency procedure in case of power cable dig-up with the Power Authority and all crew members on a regular basis.

STATIC ELECTRICAL ENERGY GENERATION

Most noticeable in pipe coated with Trilaminate, static potential buildup can reach up to 30,000 volts and is unpleasant for persons in contact with line. Also, there have been instances of ignition of rags soaked in cleaning fluids during preparation of weld margins for wrapping.

The following are the most common cause of electro-station generation:

- Sand and dust being blown over the pipe. The higher the velocity, the greater the charge
- Grit blasting of the weld prior to wrapping
- Railway lines having a mutual coupling effect
- Solar activity and changes in the Earth's magnetic field (more often in pipelines running north to south and is called planetary or telluric effect)

Management

- Efficient earthing of welded pipe strings using the same methodology as induced voltage
- Maintain a distance of at least 3 welds between grit blasting and pre-wrapping
- Ensure that personnel are aware of the hazard and management methods

PORTABLE POWER GENERATION EQUIPMENT FOR ELECTRONICALLY POWER HAND TOOLS

Defective extension leads and electronically powered hand tools are the most common cause of electrical shock to construction workers. The very nature of pipeline construction that relies on a repetitive production process by crews moving along the ROW, means that extension leads and tools are prone to a higher level of physical damage.

Welding crews are most at risk from defective electrical equipment. This equipment uses quite high voltage to do its job (15,000V to 30,000V) but usually at a low amperage. However, they can be dangerous especially to those with existing heart conditions.

Management

- Inspection and tagging of all extension leads and power tools in accordance with AS 3000
- Use of an earth leakage circuit breaker (ELCB) between the AC power generation source and electrical equipment
- Development of a culture of continual visual monitoring of electrical equipment by work crews and the removal from service of defective or suspect equipment
- Set up of welding rigs to minimise the risk of physical damage to extension leads and electrical power tools and the possibility of immersion in water (eg pools of water on the ROW)
- Ongoing information and training sessions for work crews through inductions and toolbox meetings
- Use of equipment in accordance with manufacturers instruction
- Compliance with recommended maintenance routines for portable generating equipment (including welding generator sets)

References

1. AS 3000 Wiring Rules
2. AS 3007 Earthing Systems
3. AS 2885.1997; Pipelines—Gas and Liquid Petroleum Pt 1, Design and Construction
4. AS 2832.1998; Guide to the Cathodic Protection of Metals PT 1, Pipes, Cables and Ducts
5. AS 1768.1991; Lightning Protection
6. AS 1674.1990; Safety in Wleding and Allied Processes Pt 2, Electrical NACE Recommended Practice RP0177-95